WHAT IS CLAIMED

1. An image forming apparatus, comprising:

an image carrier configured to carry toner images and pattern toner images;

an endless transfer belt configured to one of directly and indirectly receive the toner images and the pattern toner images from the image carrier; and

a position shift detector configured to detect positions of pattern toner images formed on the image carrier to obtain position shift data used to calculate moving average values of N number of the position shift data when N is an integer equal to or greater than 1, pattern toner images are formed on the image carrier at an interval of 1/N of a circumferential length of the image carrier, and the pattern toner images are transferred from the image carrier onto the transfer belt over one cycle length of the transfer belt.

2. An image forming apparatus, comprising:

an image carrier configured to carry toner images and pattern toner images;

an endless transfer belt configured to one of directly and indirectly receive the toner images and the pattern toner images from the image carrier;

a drive roller configured to drive the transfer belt; and

a position shift detector configured to detect positions of pattern toner images formed on the image carrier to obtain position shift data used to calculate moving average values of M number of the position shift data when M is an integer equal to or greater than 1, pattern toner images are formed on the image carrier at an interval of 1/M of a circumferential length of a circle having a diameter equal to a length in which an average thickness of the transfer belt is added to a diameter of the drive roller, and the pattern toner images are transferred from the image carrier onto the transfer belt over one cycle length of the transfer belt.

3. An image forming apparatus, comprising:

an image carrier configured to carry toner images and pattern toner images;

an endless transfer belt configured to one of directly and indirectly receive the toner images and the pattern toner images from the image carrier;

a drive roller configured to drive the transfer belt; and

a position shift detector configured to detect positions of pattern toner images formed on the image carrier to obtain position shift data use to calculate first moving average values of n X N number of the position shift data and second moving average values of n X M number of the first moving average values when each of N, M, and n is an integer equal to or greater than 1, a ratio between a circumferential length of the image carrier and a circumferential length of a circle having a diameter equal to a length in which an average thickness of the transfer belt is added to a diameter of the drive roller is set to N:M, pattern toner images are formed on the image carrier at an interval of 1/n X N of the circumferential length of the image carrier, and the pattern toner images are transferred from the image carrier onto the transfer belt over one cycle length of the transfer belt.

4. The image forming apparatus according to claim 1, further comprising:

a control circuit configured to calculate the moving average values of the N number of the position shift data by a center average method.

5. The image forming apparatus according to claim 2, further comprising:

a control circuit configured to calculate the moving average values of the M number of the position shift data by a center average method.

6. The image forming apparatus according to claim 3, further comprising:

a control circuit configured to calculate the first and second moving average values by a center average method.

7. The image forming apparatus according to claim 1, further comprising:

a drive roller;

at least one driven roller, the drive roller and the at least one driven roller surrounded by the transfer belt; and

a control device configured to control a rotational speed of the drive roller based on the calculated moving average values to correct a speed variation of the transfer belt caused by an uneven thickness of the transfer belt in a circumferential direction of the transfer belt.

8. The image forming apparatus according to claim 2, further comprising:

at least one driven roller, the drive roller and the at least one driven roller surrounded by the transfer belt; and

a control device configured to control a rotational speed of the drive roller based on the calculated moving average values to correct a speed variation of the transfer belt caused by an uneven thickness of the transfer belt in a circumferential direction of the transfer belt.

9. The image forming apparatus according to claim 3, further comprising:

at least one driven roller, the drive roller and the at least one driven roller surrounded by the transfer belt; and

a control device configured to control a rotational speed of the drive roller based on the calculated second moving average values to correct a speed variation of the transfer belt caused by an uneven thickness of the transfer belt in a circumferential direction of the transfer belt.

10. The image forming apparatus according to claim 1, further comprising:

a control circuit configured to calculate the moving average values before rotation of the transfer belt.

11. The image forming apparatus according to claim 2, further comprising:

a control circuit configured to calculate the moving average values before rotation of the transfer belt.

12. The image forming apparatus according to claim 3, further comprising:

a control circuit configured to calculate the first and second moving average values before rotation of the transfer belt.

13. The image forming apparatus according to claim 1, further comprising:

a control circuit configured to calculate the moving average values when a number of images formed with the image forming apparatus exceeds a predetermined number.

14. The image forming apparatus according to claim 2, further comprising:

a control circuit configured to calculate the moving average values when a number of images formed with the image forming apparatus exceeds a predetermined number.

15. The image forming apparatus according to claim 3, further comprising:

a control circuit configured to calculate the first and second moving average values when a number of images formed with the image forming apparatus exceeds a predetermined number.

16. A method of detecting and correcting position shift in a color toner image formed on one of a transfer belt and a recording medium carried and conveyed on the transfer belt, the method comprising:

forming pattern toner images on an image carrier at an interval of 1/N of a circumferential length of the image carrier, where N is an integer equal to or greater than 1;

transferring the pattern toner images from the image carrier onto the transfer belt over one cycle length of the transfer belt;

detecting positions of the pattern toner images to obtain position shift data;

calculating moving average values of N number of the position shift data; and

controlling a rotational speed of a drive roller configured to drive the transfer belt based on the calculated moving average values.

17. A method of detecting and correcting position shift in a color toner image formed on one of a transfer belt and a recording medium carried and conveyed on the transfer belt, the method comprising:

forming pattern toner images on an image carrier at an interval of 1/M of a circumferential length of a circle having a diameter equal to a length in which an average thickness of the transfer belt is added to a diameter of a drive roller configured to drive the transfer belt, where M is an integer equal to or greater than 1;

transferring the pattern toner images from the image carrier onto the transfer belt over one cycle length of the transfer belt;

detecting positions of the pattern toner images to obtain position shift data;

calculating moving average values of M number of the position shift data; and

controlling a rotational speed of the drive roller based on the calculated moving average values.

18. A method of detecting and correcting position shift in a color toner image formed on one of a transfer belt and a recording medium carried and conveyed on the transfer belt, the method comprising:

setting a ratio between a circumferential length of an image carrier and a circumferential length of a circle having a diameter equal to a length in which an average thickness of the transfer belt is added to a diameter of a drive roller configured to drive the transfer belt to N:M, where each of N and M is an integer equal to or greater than 1;

forming pattern toner images on the image carrier at an interval of 1/n X N of the circumferential length of the image carrier, where n is an integer equal to or greater than 1;

transferring the pattern toner images from the image carrier onto the transfer belt over one cycle length of the transfer belt;

detecting positions of the pattern toner images to obtain position shift data;

calculating first moving average values of n X N number of the position shift data;

calculating second moving average values of n X M number of the first moving average values; and

controlling a rotational speed of the drive roller based on the calculated second moving average values.

19. The method according to claim 16, wherein the moving average values of the N number of the position shift data are calculated by a center average method.

20. The method according to claim 17, wherein the moving average values of the M number of the position shift data are calculated by a center average method.

21. The method according to claim 18, wherein the first and second moving average values are calculated by a center average method.

22. The method according to claim 16, wherein the moving average values are calculated before rotation of the transfer belt.

23. The method according to claim 17, wherein the moving average values are calculated before rotation of the transfer belt.

24. The method according to claim 18, wherein the first and second moving average values are calculated before rotation of the transfer belt.

25. The method according to claim 16, wherein the moving average values are calculated when a number of images formed exceeds a predetermined number.

26. The method according to claim 17, wherein the moving average values are calculated when a number of images formed exceeds a predetermined number.

27. The method according to claim 18, wherein the first and second moving average values are calculated when a number of images formed exceeds a predetermined number.

28. An image forming apparatus, comprising:

means for carrying toner images and pattern toner images;

means for one of directly and indirectly receiving the images; and

means for detecting positions of pattern toner images formed on the means for carrying images to obtain position shift data used to calculate moving average values of N number of the position shift data when N is an integer equal to or greater than 1, pattern toner images are formed on the image carrying means at an interval of 1/N of a circumferential length of the means for carrying images, and the pattern toner images are transferred from the means for carrying images onto the means for receiving images.

29. An image forming apparatus, comprising:

means for carrying toner images and pattern toner images;

means for one of directly and indirectly receiving the images;

means for driving the means for receiving images; and

means for detecting positions of pattern toner images formed on the means for carrying images to obtain position shift data used to calculate moving average values of M number of the position shift data when M is an integer equal to or greater than 1, pattern toner images are formed on the means for carrying images at an interval of 1/M of a circumferential length of a circle having a diameter equal to a length in which an average thickness of the means for receiving images is added to a diameter of the means for driving, and the pattern toner images are transferred from the means for carrying images onto the means for receiving images over one cycle length of the means for receiving images.

30. An image forming apparatus, comprising:

means for carrying toner images and pattern toner images;

means for one of directly and indirectly receiving the images;

means for driving the means for receiving images; and

means for detecting positions of pattern toner images formed on the means for carrying images to obtain position shift data used to calculate first moving average values of n X N

number of the position shift data and second moving average values of n X M number of the first moving average values when each of N, M, and n is an integer equal to or greater than 1, a ratio between a circumferential length of the means for carrying images and a circumferential length of a circle having a diameter equal to a length in which an average thickness of the means for receiving images is added to a diameter of the means for driving is set to N:M, pattern toner images are formed on the means for carrying images at an interval of 1/n X N of the circumferential length of the means for carrying images, and the pattern toner images are transferred from the means for carrying images onto the means for receiving images over one cycle length of the means for receiving images.

31. The image forming apparatus according to claim 28, further comprising:

means for controlling a rotational speed of the means for driving based on the calculated moving average values to correct a speed variation of the means for receiving images caused by an uneven thickness of the means for receiving images in a circumferential direction of the means for receiving images.

32. The image forming apparatus according to claim 29, further comprising:

means for controlling a rotational speed of the means for driving based on the calculated moving average values to correct a speed variation of the means for receiving images caused by an uneven thickness of the means for receiving images in a circumferential direction of the means for receiving images.

33. The image forming apparatus according to claim 30, further comprising:

means for controlling a rotational speed of the means for driving based on the calculated second moving average values to correct a speed variation of the means for receiving images caused by an uneven thickness of the means for receiving images in a circumferential direction of the means for receiving images.